AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A system for animating a face, comprising:

a ~~facial reconstruction~~ surface acquisition arrangement for acquiring ~~a base surface model representing~~ a set of three-dimensional surface models that approximate a shape of a subject's face in different poses, the surface models including a base surface model that includes a set of control points which have default position vectors, the surface models further including at least one sequence of surface models such that the surface models in a given sequence approximate the shape of the subject's face at successive phases of a particular one of muscle movement and facial expression, and for acquiring a set of displacement fields representing motion patterns of the subject's face~~, wherein the base surface model includes a set of control points and~~ such that each displacement field generates a three-dimensional displacement vector that varies over the control points of the base surface model and over an intensity variable;

a displacement field derivation unit configured to derive one of the displacement fields from one of the sequences of surface models by mapping the control points of the base surface model to positions in the surface of each of the surface models in the sequence, and by calculating a displacement of each control point from its mapped position in the first surface model in the sequence to its mapped position in each of the other surface models in the sequence;

a storage arrangement for storing the set of surface models and the set of displacement fields;

an intensity generator to generate a current intensity value for each displacement field in the set of displacement fields;

a deformation unit to combine the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the ~~positions~~ default position vectors of the control points to generate a deformed surface model;

a rendering unit to translate the deformed surface model into a two-dimensional image of the face; and

a video output subsystem to at least one of display and store the two-dimensional image.

2. (Original) The system of claim 1, wherein the base surface model represents a shape of the face in a neutral, relaxed pose.

3. (Canceled).

4. (Currently Amended) The system of claim [[3]] 1, wherein each of the surface models of the set of surface models acquired from the subject's face includes:

a set of three-dimensional points measured from the subject's face;

a topological model representing a set of vertices and connections between them; and

an association between the set of three-dimensional points and the vertices which determines an embedding of the topological model in three-dimensional space.

5. (Currently Amended) The system of claim [[3]] 1, wherein the surface acquisition arrangement includes an active sensing arrangement for surface measurement.

6. (Original) The system of claim 5, wherein the active sensing arrangement projects a grid pattern for surface measurement.

7. (Original) The system of claim 5, wherein the active sensing arrangement projects a pattern of multiple parallel stripes for surface measurement.

8. (Canceled).

9. (Currently Amended) The system of claim [[3]] 1, wherein one of the ~~surface acquisition arrangement acquires a sequence of surface models from a sequence of facial poses involving a particular muscle movement; and wherein the facial reconstruction arrangement is configured to associate~~ sequences of surface models is associated to a sequence ~~of increasing~~ corresponding intensity values ~~with the sequence of surface models~~, ~~the~~ each intensity ~~values~~ value representing ~~degrees~~ a degree of muscle contraction for the particular one of muscle movement and expression ~~in~~ corresponding ~~poses in~~ to the sequence of ~~facial poses~~ surface models.

10. (Currently Amended) ~~The system of claim 9~~ A system for animating a face, comprising:

a facial reconstruction arrangement for acquiring a base surface model representing a three-dimensional shape of a subject's face, and for acquiring a set of displacement fields representing motion patterns of the subject's face, wherein the base surface model includes a set of control points and each displacement field generates a three-dimensional displacement vector that varies over the control points and over an intensity variable;

an intensity generator to generate a current intensity value for each displacement field in the set of displacement fields;

a deformation unit to combine the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the positions of the control points to generate a deformed surface model;

a rendering unit to translate the deformed surface model into a two-dimensional image of the face; and

a video output subsystem to at least one of display and store the two-dimensional image,

wherein the facial reconstruction arrangement includes a surface acquisition arrangement for acquiring a set of surface models that approximate shapes of the subject's face, and a storage arrangement for storing the set of acquired surface models,

wherein the surface acquisition arrangement acquires a sequence of surface models from a sequence of facial poses involving a particular muscle movement,

wherein the facial reconstruction arrangement is configured to associate a sequence of increasing intensity values with the sequence of surface models, the intensity values representing degrees of muscle contraction for the particular muscle movement in corresponding poses in the sequence of facial poses, and

wherein the facial reconstruction arrangement further includes a jaw immobilizer to minimize differences in jaw position during different poses in the sequence of facial poses involving the particular muscle movement.

11. (Currently Amended) The system of claim [[9]] 1, further including ~~wherein the facial reconstruction arrangement further includes~~ a surface registration unit to geometrically align the surface models to minimize differences in head position.

12. (Currently Amended) The system of claim 11, wherein the surface registration unit applies an iterative closest point technique to geometrically align the surface models ~~in the sequence of surface models~~.

13. (Canceled).

14. (Currently Amended) ~~The system of claim 13~~ A system for animating a face, comprising:

a facial reconstruction arrangement for acquiring a base surface model representing a three-dimensional shape of a subject's face, and for acquiring a set of displacement fields representing motion patterns of the subject's face, wherein the base surface model includes a set of control points and each displacement field generates a three-dimensional displacement vector that varies over the control points and over an intensity variable;

an intensity generator to generate a current intensity value for each displacement field in the set of displacement fields;

a deformation unit to combine the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the positions of the control points to generate a deformed surface model;

a rendering unit to translate the deformed surface model into a two-dimensional image of the face; and

a video output subsystem to at least one of display and store the two-dimensional image,

wherein the facial reconstruction arrangement includes a surface acquisition arrangement for acquiring a set of surface models that approximate shapes of the subject's face, and a storage arrangement for storing the set of acquired surface models,

wherein the surface acquisition arrangement acquires a sequence of surface models from a sequence of facial poses involving a particular muscle movement,

wherein the facial reconstruction arrangement is configured to associate a sequence of increasing intensity values with the sequence of surface models, the intensity values representing degrees of muscle contraction for the particular muscle movement in corresponding poses in the sequence of facial poses,

wherein the facial reconstruction arrangement further includes a displacement field derivation unit to derive one of the displacement fields in the set of displacement fields from the sequence of surface models, and

wherein the displacement field derivation unit is configured to:

re-position the control points of the base surface model to fit the shape of each particular surface model in the sequence of surface models to produce a sequence of deformed surface models approximating the original sequence of surface models but having the control points of the base surface model;

calculate the displacements of the control points of the base surface model at each particular intensity value in the sequence of intensity values, by calculating the displacement of each control point from its position in the deformed surface model associated with the first intensity value in the sequence of intensity values to a position in the deformed surface model associated with the particular intensity value; and

derive the displacement field by determining the displacements of the control points of the base surface model at intensity values intermediate to the intensity values in the sequence of intensity values, by interpolating between the displacements at the intensity values in the sequence of intensity values.

15. (Original) The system of claim 14, wherein the displacement field derivation unit performs a linear interpolation of the displacements at the intensity values in the sequence of intensity values.

16. (Original) The system of claim 14, wherein the displacement field derivation unit performs a non-linear interpolation of the displacements at the intensity values in the sequence of intensity values.

17. (Original) The system of claim 14, wherein the displacement field derivation unit maps the control points to positions in the surface of the particular surface model.

18. (Original) The system of claim 14, wherein the displacement field derivation unit maps regions of the surface of the base surface model to corresponding regions of the surface of the particular surface model.

19. (Original) The system of claim 18, wherein the surface acquisition arrangement acquires a photographic image of the subject's face at the same time as it performs the three-dimensional measurements used to make a surface model in the set of surface models, and wherein the surface acquisition arrangement associates the photographic image with the surface model as a texture, and wherein the displacement field derivation unit maps regions

of the surface of a surface model to corresponding regions of the surface of another surface model using the textures of the two surface models.

20. (Original) The system of claim 19, wherein the displacement field derivation unit uses a network of lines that are drawn on the subject's face and appear in the texture of each surface model in the set of surface models to map regions of the surface of a surface model to corresponding regions of a surface of another surface model.

21. (Original) The system of claim 1, wherein the current intensity values for the displacement fields are sampled from a set of time-varying functions.

22. (Original) The system of claim 1, wherein the current intensity values for the displacement fields are manually input.

23. (Original) The system of claim 1, wherein the current intensity values for the displacement fields are supplied by a speech animation program.

24. (Currently Amended) The system of claim 1, wherein the deformation unit combines the position vector at each control point of the base surface model with the displacement vectors generated by the displacement fields at ~~each control point with the position of the~~ that control point by vector sum.

25. (Original) The system of claim 1, wherein the rendering unit translates the deformed surface model into the two-dimensional image using color values associated with the base surface model.

26. (Original) The system of claim 1, wherein the two-dimensional image includes a bit map.

27. (Currently Amended) A method for animating a face, comprising:

acquiring a base surface model representing a three-dimensional shape of the face and including a set of control points which have default position vectors;

acquiring ~~through three-dimensional measurement~~ a set of three-dimensional surface models ~~displacement fields~~ approximating ~~motion patterns of~~ a shape of a subject's face in different poses, the set including at least one sequence of surface models such that the surface models in a given sequence approximate the shape of the subject's face at successive phases of a particular one of muscle movement and expression;

mapping the control points of the base surface model to positions in at least one surface of the other surface models;

for each sequence of surface models, calculating a displacement of each control point from its mapped position in the first surface model in the sequence to its mapped position in each of the other surface models in the sequence, to derive a displacement field corresponding to that sequence of surface models, which ~~each~~ displacement field ~~generating~~ generates a three-dimensional displacement vector ~~varying~~ that varies over the control points of the base surface model and over an intensity variable;

generating a current intensity value for each displacement field ~~in the set of displacement fields~~;

combining the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the ~~positions~~ default position vectors of the control points to generate a deformed surface model;

rendering the deformed surface model to generate a two-dimensional visual image of the face; and

displaying or storing the two-dimensional image.

28. (Original) The method of claim 27, wherein the base surface model represents a shape of the face in a neutral, relaxed pose.

29. (Canceled).

30. (Currently Amended) The method of claim [[29]] 27, wherein the set of surface models acquired from the subject's face includes the base surface model.

31. (Currently Amended) The method of claim [[29]] 27, wherein each of the surface models acquired from the subject's face includes:

a set of three-dimensional points measured from the subject's face;

a topological model representing a set of vertices and connections between them; and

an association between the set of three-dimensional points and the vertices which determines an embedding of the topological model in three-dimensional space.

32. (Currently Amended) The method of claim [[29]] 27, wherein the set of surface models is acquired from the subject's face using measurement by active sensing.

33. (Original) The method of claim 32, wherein the active sensing includes projecting a grid pattern.

34. (Original) The method of claim 32, wherein the active sensing includes projecting a pattern of multiple parallel stripes.

35. (Currently Amended) The method of claim [[29]] 27, wherein ~~the set of acquired surface models includes a sequence of surface models acquired from a sequence of facial poses involving a particular muscle movement; and wherein a sequence of increasing intensity values is associated with this sequence of surface models, the~~ one of the sequences of surface models is associated to a sequence of corresponding intensity values, each intensity value representing ~~degrees~~ a degree of muscle contraction for the particular one of muscle movement and expression ~~in the~~ corresponding ~~poses in~~ to the sequence of ~~facial poses~~ surface models.

36. (Currently Amended) ~~The method of claim 35,~~ A method for animating a face, comprising:

acquiring a base surface model representing a three-dimensional shape of the face and including a set of control points;

acquiring through three-dimensional measurement a set of displacement fields approximating motion patterns of a subject's face, each displacement field generating a three-dimensional displacement vector varying over the control points of the base surface model and over an intensity variable;

generating a current intensity value for each displacement field in the set of displacement fields;

combining the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the positions of the control points to generate a deformed surface model;

rendering the deformed surface model to generate a two-dimensional visual image of the face; and

displaying or storing the two-dimensional image,

wherein the step of acquiring the set of displacement fields includes acquiring a set of surface models approximating shapes of the subject's face,

wherein the set of acquired surface models includes a sequence of surface models acquired from a sequence of facial poses involving a particular muscle movement,

wherein a sequence of increasing intensity values is associated with this sequence of surface models, the intensity values representing degrees of muscle contraction for the muscle movement in the corresponding poses in the sequence of facial poses, and

wherein the subject's jaw is immobilized to minimize differences in jaw position during different poses in the sequence of facial poses of the particular muscle movement.

37. (Currently Amended) The method of claim [[35]] 27, wherein the surface models ~~in the sequence of surface models~~ are geometrically aligned to minimize differences in head position.

38. (Original) The method of claim 37, wherein the geometric alignment of the surface models includes application of an iterative closest point technique.

39. (Canceled).

40. (Currently Amended) ~~The method of claim 39~~ A method for animating a face, comprising:

acquiring a base surface model representing a three-dimensional shape of the face and including a set of control points;

acquiring through three-dimensional measurement a set of displacement fields approximating motion patterns of a subject's face, each displacement field generating a three-dimensional displacement vector varying over the control points of the base surface model and over an intensity variable;

generating a current intensity value for each displacement field in the set of displacement fields;

combining the displacement vectors generated by the displacement fields at the control points and at the current intensity values with the positions of the control points to generate a deformed surface model;

rendering the deformed surface model to generate a two-dimensional visual image of the face; and

displaying or storing the two-dimensional image,

wherein the step of acquiring the set of displacement fields includes acquiring a set of surface models approximating shapes of the subject's face,

wherein the set of acquired surface models includes a sequence of surface models acquired from a sequence of facial poses involving a particular muscle movement,

wherein a sequence of increasing intensity values is associated with this sequence of surface models, the intensity values representing degrees of muscle contraction for the muscle movement in the corresponding poses in the sequence of facial poses,

wherein one of the displacement fields in the set of displacement fields is derived from the sequence of surface models, and

wherein the derivation of the displacement field comprises the steps of:

re-positioning control points of the base surface model to fit the shape of each particular surface model in the sequence of surface models to produce a sequence of deformed surface models approximating the original sequence of surface models but having the control points of the base surface model;

calculating the displacements of the control points of the base surface model at each particular intensity value in the sequence of intensity values, by calculating the displacement of each control point from its position in the deformed surface model associated with the first intensity value in the sequence of intensity values to its position in the deformed surface model associated with the particular intensity value; and

deriving the displacement field by determining the displacements of the control points of the base surface model at intensity values intermediate to the intensity values in the sequence of intensity values, by interpolating between the displacements at the intensity values in the sequence of intensity values.

41. (Original) The method of claim 40, wherein the step of interpolating the displacements at the intensity values in the sequence of intensity values includes performing a linear interpolation.

42. (Original) The method of claim 40, wherein the step of interpolating the displacements at the intensity values in the sequence of intensity values includes performing a non-linear interpolation.

43. (Original) The method of claim 40, wherein the step of re-positioning the control points of the base surface model to fit the shape of the particular surface model includes mapping the control points to positions in the surface of the particular surface model.

44. (Original) The method of claim 43, wherein the mapping of the control points of the base surface model to positions in the surface of the particular surface model includes mapping regions of the surface of the base surface model to corresponding regions of the surface of the particular surface model.

45. (Original) The method of claim 44, wherein each surface model in the set of surface models has associated with it a photographic image of the subject's face that is acquired by the surface acquisition system at the same time as the three-dimensional measurements used to make the surface model, the photographic image being mapped to the surface of the surface model as a texture; and wherein the mapping of regions of the surface of the base surface model to corresponding regions of the particular surface model includes usage of the textures of the two surface models.

46. (Original) The method of claim 45, wherein prior to acquiring the set of surface models a network of lines is drawn on the subject's face dividing it into regions, the network of lines consequently appearing in the texture of each surface model; and wherein the mapping of regions of the surface of the base surface model to corresponding regions of the particular surface model includes usage of the network of lines appearing in the textures of the two surface models.

47. (Original) The method of claim 27, wherein the current intensity values for the displacement fields are sampled from a set of time-varying functions.

48. (Original) The method of claim 27, wherein the current intensity values for the displacement fields are manually input.

49. (Original) The method of claim 27, wherein the current intensity values for the displacement fields are supplied by a speech animation program.

50. (Currently Amended) The method of claim 27, wherein the step of combining the position vector of each control point of the base surface model with the displacement vectors

generated by the displacement fields at ~~each control point with the position of the~~ that control point includes calculating a vector sum.

51. (Original) The method of claim 27, wherein the rendering step includes using color values associated with the base surface model.

52. (Original) The method of claim 27, wherein the two-dimensional image includes a bit map.

53. (Canceled).

54. (New) The system of claim 1, wherein the surface acquisition arrangement further includes a jaw immobilizer to minimize differences in the position of the subject's jaw at different phases of a particular muscle movement.

55. (New) The system of claim 9, wherein the displacement field derivation unit is configured to:

re-position the control points of the base surface model to fit the shape of each particular surface model in one of the sequences of surface models to produce a sequence of deformed surface models approximating the original sequence of surface models but having the control points of the base surface model;

calculate the displacements of the control points of the base surface model at each particular intensity value in the sequence of intensity values, by calculating the displacement of each control point from its position in the deformed surface model associated with the first intensity value in the sequence of intensity values to a position in the deformed surface model associated with the particular intensity value; and

derive the displacement field by determining the displacements of the control points of the base surface model at intensity values intermediate to the intensity values in the sequence of intensity values, by interpolating between the displacements at the intensity values in the sequence of intensity values.

56. (New) The method of claim 27, wherein the subject's jaw is immobilized to minimize the differences in jaw position at different phases of a particular muscle movement.

57. (New) The method of claim 35, wherein the derivation of the displacement field comprising:

re-positioning control points of the base surface model to fit the shape of each particular surface model in the sequence of surface models to produce a sequence of deformed surface models approximating the original sequence of surface models but having the control points of the base surface model;

calculating the displacements of the control points of the base surface model at each particular intensity value in the sequence of intensity values, by calculating the displacement of each control point from its position in the deformed surface model associated with the first intensity value in the sequence of intensity values to its position in the deformed surface model associated with the particular intensity value; and

deriving the displacement field by determining the displacements of the control points of the base surface model at intensity values intermediate to the intensity values in the sequence of intensity values, by interpolating between the displacements at the intensity values in the sequence of intensity values.